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EXPLOITATION OF THE CHEMICAL BASIS OF INSECT PLANT INTERRELATIONSHIPS FOR ECOLOGICALLY COMPATIBLE PEST MANAGEMENT

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ABSTRACT

Plants constitute basic elements in the biosphere fabric and the continuous interaction of insects with plants. The secretion of some chemicals by plant forces insects to change their habits. In this paper such changes have been discussed for exploitation of these types of chemicals in developing ecologically compatible pest management.

Plants are the basic primary elements interwoven into the fabric of the biosphere. As such, the plants are in continuous interaction of varying degrees and intensities with other life forms. Of the latter, the insects in general and the phytophagus species in particular have perhaps the most ubiquitous, intense and dynamic interrelationships with plants. It has now been firmly established that these interrelationships have a firm basis in specific physicochemical attributes of plants which have evolved over the geological epochs and presumably continue in a state of dynamic flux, changing and adapting to the demands of equally unstable ecosystem heuristics. The chemistry of these plant adaptations, however, affords an opportunity to manipulate insect behaviour and physiology. This can be of current and futuristic practical advantage in the management of insect populations competing with man for food or fibre. Literature is replete with citations of sporadic and individual attempts of greater or lesser scope in identification and or isolation of such potent chemical principles. During the past few years, drawing upon multidisciplinary expertise and facilities, an attempt has.been made at the National Chemical Laboratory of India to develop systematised comprehensive protocols for elucidation and exploitation of the chemical basis of Insect Pest Host Plant Relationships. That the ultimate objective viz. identification and development of ecologically compatible pest management agents is within possibility and capability of realisation if expouded with concrete examples.

Plants are the basic biotic elements which, in the ultimate analysis, provide for and contribute to sustenence, development and evolution of all forms of life on this planet. With the phytophagus insects they exhibit a singularly intricate and unique web of interrelationships developed over epochs of geological time and still continuing to evolve in the present also. The herbivorus insects and their host plants present a remarkable example of co-existence and co-evolution over millenia, interacting and adapting one another's needs.

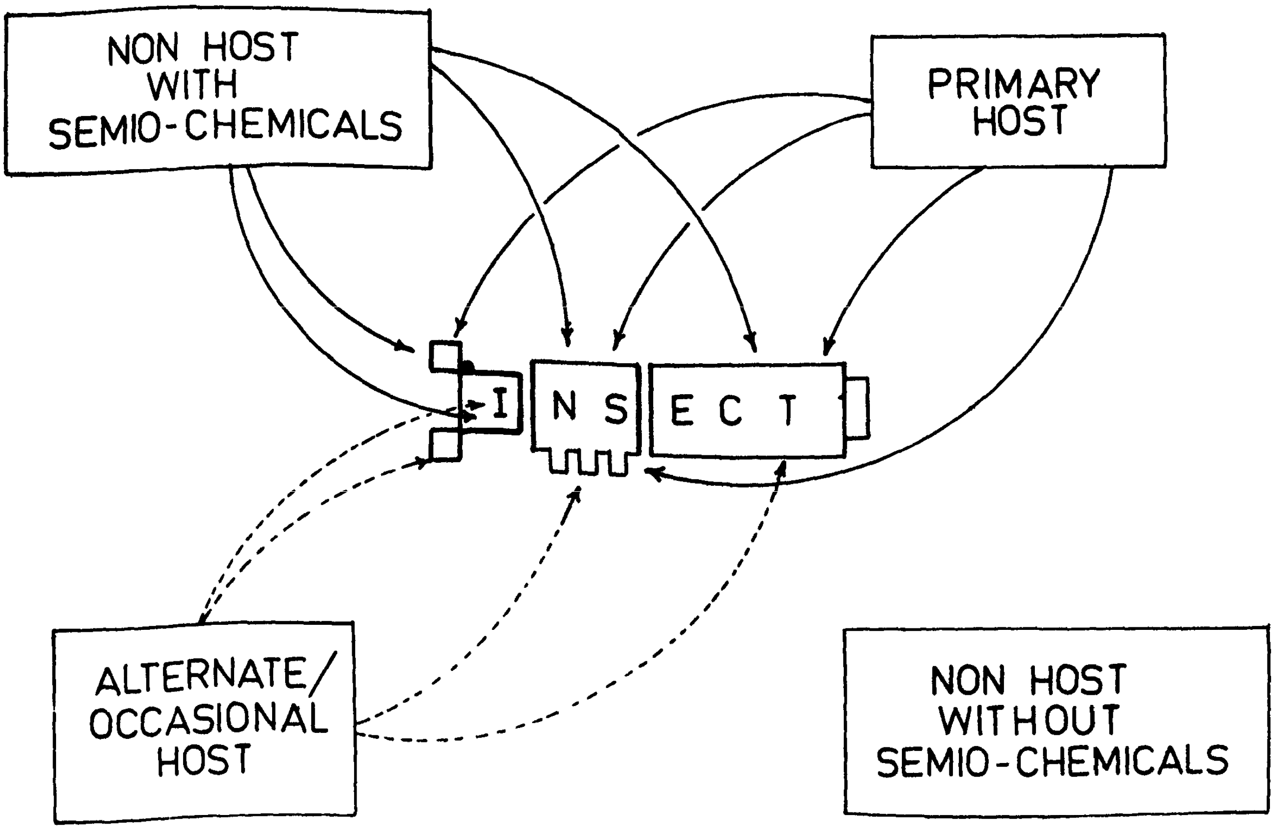
(Fenny, 1983).Many of these adaptations which have become incorporated in the plants have a chemical basis or origin. Indeed, the major basis of insect plant interrelationships is mainly chemical. The insects are known to have an elaborate system of chemical communication amongst their own kind (Schneider, 1965). In a much broader perspective and on an evolutionary scale they seem to have developed an inter-taxa, indeed, inter kingdom system of dynamic interaction based primarily on specific chemical compounds. By a stretch of imagination this system can be visualised as one for 'intercommunication' between disparate biotaxonomic entities over evolutionary time scales. However, that may be, the existence of specific chemicals in plants affecting insect behaviour, physiology and development has now been established beyond any doubt (Franenkel, 1969, Browns *et al* 1970, Marini Bettolo, 1983). These chemicals have been variously labelled as secondary chemicals, allelo-chemics, semiochemicals (Nordlund, 1981) etc. Their role in plant physiology may be obscure but that in inter taxa semantics is no longer in doubt. Thus, various allelo-chemics are known which generally or selectivity affect specific aspects of insect behaviour, growth, physiology and development. The degree of bioactivity of these chemicals as reflected in their capacity to disrupt or disorganise insect biology and development, determine both their academic as well as applied value.

The advent of High Technology in all human spheres of activity, including agriculture has tremendously increased environmental pollution. Not a small part of this menace is due to the employment of highly toxic synthetic organic molecules for pest eradication in agro-ecosystems (Carson, 1962, Edwards, 1973). There can be no denying, of course, of the contribution of these chemicals in ushering in Green Revolutions all over the globe (Quraishi, 1977, Sharma, 1982). There can also be no laxity in the maintenence and increase in agricultural production just to keep pace with the ever increasing human population and needs. The conventional toxic pesticides have, however, become and anachronism in context of modern comprehensions and concerns with the problems of pollution (Sharma, 1984). Efforts are being made all over the world, to isolate, identify and where possible to synthesise, bioactive chemical compounds and products in ecological harmony with natural ecosystems for utilization in biorational pest management programmes. Necessarily, an unbelievably rich and inexhaustible source of ideas and structures for such principles are the plants themselves.

Examined along with their major patterns of interaction with the herbivorous insects, plants are a vast and unique treasure house of leads for the development of futuristic pest management strategies. A broad categorization of the major insect plant interrelationships has been schematically depicted. The primary and secondary hosts constitute the first two types of plants having profound exchanges with the herbivorous pest/predator insect. The basis of these exchanges are primarily chemical. Thus, except for the visual stimulii, these may readily affect and elicit immediate overt responses from the insect or may covertly but nevertheless radically affect insect physiology and development. In either case the interaction between the plant and the insect is intimate and precise, resulting in the establishment as well as continuing evolution of definite trends of relationships. The chemical basis of the latter can be dissected, principles identified and possibly used in special strategies of pest management. An important category of plants in this context are the non-hosts with semiochemicals. The latter may be randomly distributed over a wide assortment of plants with or without any definite relationship with the insect or the ecosystem. However, what is important here is that such semio-chemicals in non-host plants are likely to be more potent and generalised in their effects on a smaller or broader range of insects that the ones occurring in known host plants of specific insect pests.

In modern attempts to tap this rich floral vein for chemical leads to potential pest control agents of the future, the non host plant with semio-chemicals constitute an important source. Such plants may be assessed randomly or in individual systems based on literature, folklore, taxonomy, bio-ecology, or even plain intution may be used (Sharma, 1984). The assessment made can be sporadic and limited or highly systematized and broad based. In either case, scope for more investigations must continue to be considerable and no plant must be totally rejected as being unworthy of further interest.

At the National Chemical Laboratory (NCL) of India, a broad based highly systematized programme of bio-evaluation of indigenous plant and other natural products for specific bio-activities against different insect pests has been under way for nearly 5 years. The programme has been described and discussed in some detail in the author's earlier several publications (Sharma, 1982, Sharma, 1983, Sharma, 1984, Sharma *et al.*, 1985, Sharma, 1985). It may only be mentioned here that successes in such an enterprise are hard to come by, but can be very rewarding and fulfilling when these are achieved. In the 5 years of operation of this programme at the NCL, we have been able to put as many as 250 plants through a really comprehensive screen consisting of over a dozen test species of insect pests and


NON HOST WITH SEMIO-CHEMICALS
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NON HOST WITHOUT SEMIO-CHEMICALS

Bioevaluation of Indigenous Plants & Natural Products.

vectors, and an equal number of different bioactivities covering the entire spectrum from acutely lethal to non-toxic behaviour modifiers, hormonal analogues and development inhibitors. Discounting merely positive results, we have obtained 70 leads of definite promise which deserve closer examination and followup action towards Product Development. Of these, we have actually taken up three for such work and one behaviour manipulating product has already been tested in actual field trial.

However, it must be emphasized that these endeavours are at this point of time essentially futuristic in conception and definitely so wherein actual practical deployment is concerned. What is important is that this kind of data generation must be continued with unabated vigour. For this, deep understanding and deft investigations into the fascinating interrelationships between insects and plants are required. Exploitation of this research for the eventual development of systems and products for bio rational pest management must perhaps await greater awareness of the detriments of the pollution problem as well as broader comprehension of the potential of such subtle strategies. Technical, legal, socio-economics and bureaucratic hurdles and prejudices also need to be overcome before these bio-rational systems can make any headway. Many of the principles, problems and possibilities as well as progress achieved in these areas have been enumerated at length in the author's earlier various publications (Sharma, 1982, Sharma, 1983, Sharma, 1984, Sharma *et al.*,1985, Sharma,1985). It only remains here to reasseverate faith in the underlying soundness of the philosophy aimed at studying and unravelling especially the chemical bases of insect plant relationships and the utilisation, if possible, of the off shoots of technically and commercially viable pest control principles therefrom.

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